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TECHNICAL MANUSCRIPT 27

PROGRAMMED MAINTENANCE
AT FORT DETRICK

NOVEMBER 1962

UNITED STATES ARMY
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**U.S. ARMY CHEMICAL-BIOLOGICAL-RADIOLOGICAL AGENCY
U.S. ARMY BIOLOGICAL LABORATORIES
Fort Detrick, Maryland**

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**Technical Engineering Division
DIRECTOR OF ENGINEERING SERVICES**

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ABSTRACT

The design and implementation of an engineered maintenance program in accordance with acceptable engineering standards are described.

The need for such programming is evidenced by the increasing complexity of the modern plant and the resulting enormity of the maintenance budget. Standard procedural practices, estimated time allowances, and the use of electronic data processing machines are discussed.

Many fine articles have been published in recent years on the desirability, if not indeed the necessity, for programming of that very significant portion of the total maintenance effort that lends itself to cyclic performance.

In this period of highly mechanized plant operation, with the complexity of electronics and instrumentation that almost inevitably results, there remain but few engineers and plant managers who will not agree that maintenance must be envisioned strictly as a maintenance effort rather than a repair effort. An orderly method of maintaining machinery, equipment, and real property in efficient, continuous operation versus unscheduled downtime for overhaul or replacement at a time that is dictated by failure of the machine leaves little or no choice to the plant whose products are to continue on the market.

Industry in all fields, as well as government installations, has recognized that maintenance has become a highly complex operation, the cost of which can no longer be borne by adding a few cents per item to the end product.

The maintenance department must now assume a role of importance equivalent to that of engineering, sales, production, personnel, and accounting; there are strong indications that management generally, though in some cases reluctantly, has recognized this. It is difficult for management to fail to recognize the importance of an operation on which the all-important production is becoming ever more dependent. This increasing dependency, as well as the sheer weight of the maintenance budget, has forced recognition of the maintenance department as a position of prestige. The "jack-of-all-trades" maintenance man long supplied an important and a very creditable service to American industry. He is typical of the spirit that, in all fields, has made America industrially great. His passing is not so much a commentary on the manner in which he performed his many basic duties, as it is an evaluation by which the complexity of plant development can be measured. The modern plant is a highly complicated installation, designed by specialists, and its successful operation and maintenance remain largely in the various fields of specialization.

Experience at Fort Detrick pointed up many deficiencies in a number of related fields. Valuable scientific data, painstakingly recorded over a period of weeks or months, were frequently invalidated because studies could not be concluded as planned, due to unscheduled down-time caused by failure of equipment in service.

The loss of scientific man-hours was incalculable, resulting in the disruption of mission schedule. Excessive maintenance costs were introduced along with the substandard quality of maintenance performed under emergency conditions.

The exposure of maintenance personnel to potentially hazardous biological conditions, without the advantage of planned decontamination procedures, was sometimes necessary.

The maintenance of systems by components, rather than as an entity, greatly increased the incidence of failure.

These and other problems, some of which are peculiar to Fort Detrick and some of which are commonly experienced in conventional plant maintenance, were studied.

Accordingly, the installation commander ordered the design and implementation of a co-ordinated and standardized system of prescribing and performing maintenance. Formulation of this system was undertaken by Technical Engineering Division at Fort Detrick.

In a meeting with top management, the items considered by Engineering to be basic requirements were discussed and agreed upon. This discussion included the support required by Engineering from other segments of the command. Property Division was charged with the responsibility of keeping

the engineers informed of changes in location of portable equipment, etc. The Comptroller Division was made responsible for timely machine-processing of data. Procurement Division was informed of new stock-level requirements. Maintenance Division was directed to effect compliance with program requirements at shop level, and laboratory chiefs were advised that maintenance, other than emergencies, would be performed according to schedule, thus allowing timing of laboratory schedules and operations.

The system was to be designed around the concept of automatic machine-punched work order releases, issued at a predetermined interval of one month ahead of performance, with coded reference to written procedures for guidance in work performance.

It was clearly understood that successful over-all maintenance of a modern plant is no longer a crowbar and pipe-wrench type of operation. It requires the knowledge and application of basic (and in some fields not so basic) scientific principles translated into a comprehensive maintenance program with performance dates and step-by-step maintenance procedures prescribed by the program through written descriptions (SOP's) clearly defining the performance of each maintenance task.

The descriptions (SOP), which would be numbered, would then be assembled numerically in a maintenance manual and issued to maintenance personnel.

The SOP number would also appear on the machine-punched card (Work Order Release) along with a greatly abbreviated description of work that serves only as a work classification, e.g. "lube vac pump," "clean air-cooled condenser." The detailed description of the work for which the mechanic is responsible, and for which his base time and allowance have been estimated, is readily available to him by reference to the manual under the same SOP number as that appearing on the card.

Like-SOP numbers are applied to identical items encountered in various locations; the maintenance interval will differ, however, as in the case of like-refrigeration compressors on year-round service versus purely seasonal service.

In editing the work descriptions (SOP), the engineer should not strive for rhetorical effect. The SOP will have but one purpose, that of clearly defining the operation to the man who must finally perform the task. Engineering terminology that may be unfamiliar to the mechanic may, in some cases, improve the literary quality, but it is doubtful that it will improve the communication.

Determination of the maintenance interval must to a large degree depend upon the best judgment of the engineer charged with over-all program responsibility. Manufacturer's specifications will, in some instances, prove helpful; however, it may be reliably determined that in many cases excessive

maintenance is suggested. The tendency to over-schedule is very real and very understandable. There is a tremendous appeal in the truism "better safe than sorry," especially where judgment of the individual must be exercised, and in some instances without the advantage of any very conclusive supporting data.

It was pointed out early in the study that there was no quick and easy method that could be applied to produce a comprehensive program. Top management was advised, and they agreed that what was being contemplated was not a preventive maintenance "Check List." Engineering time would be measured, not in man-hours, but in man-years. The goal was to provide a system or method of planning, scheduling, and describing the periodic maintenance of grounds, buildings, roads, equipment, and utilities systems for the entire installation.

It should provide:

- (a) A system of automatic machine-punched work order releases at pre-determined intervals, with references to written procedures for guidance in work performance.
- (b) A means of determining in advance a very significant portion of the total maintenance work load.
- (c) A preliminary estimate of maintenance costs for fiscal budgeting.
- (d) Readily available information for determining deferred maintenance lists.
- (e) A means of scheduling work load of local forces to the best advantage.
- (f) Ordering of necessary materials with lead-time requirements.
- (g) Standard man-hours and material estimates for each repetitive operation.
- (h) A system of effective control of repetitive maintenance operations.
- (i) Furnishing of data for fixed assets accounting.
- (j) A method of transferring costs to individual installed property accounts.
- (k) Prescribed safety procedures in performing operations where special industrial and/or biological hazards are considered to exist.

Technical Engineering Division was then directed to proceed with program design. An exhaustive study was made, first to determine just what data would best serve the over-all program and, second, how the engineers assigned to making the field surveys would report the information with a minimum of explanatory effort at the survey site. To this end, a data sheet was devised and a system of combination coding and abbreviations under pertinent column headings was used.

These headings may, of course, be extended to include almost any amount of information, depending on the degree of sophistication desired. It was agreed that an effort should be made to limit the column headings to those required for maintenance and the necessary maintenance accounting data. (The tendency to free-load the program for other than maintenance data is very real.) It is from this completed data sheet that the machine operator punches the master card, which in turn, is translated in final form to the work order release card.

Each unit was conspicuously numbered for identification before the survey was undertaken.

In the final form, the data sheet includes:

- (a) An abbreviated word description of the item to be surveyed.
- (b) Manufacturer.
- (c) Property numbers.
- (d) Responsible facility.
- (e) Building use or scientific or production equipment.
- (f) Estimates standard man-hours or portion of man-hours required for maintenance as described in the appropriate SOP.
- (g) The craft involved.
- (h) The week of the year on which the prescribed maintenance effort is to be performed.
- (i) The frequency of interim maintenance operation.
- (j) The number of the maintenance description that describes to the workman precisely what maintenance is scheduled in the interval for which the work release is issued.
- (k) Location of the unit (i.e., room number, basement, machinery room, attic, etc.).

The sheet may be tailored to record additional data, where such are desirable for accounting purposes.

It is reasonable to expect that some minor failure will result from over-extension of the period, and the "Monday morning quarterback" almost certainly must have his day. A total absence of failure that can be reasonably charged against insufficient coverage in the program may even be reason to suspect that a second look at the timing intervals is indicated. This is not intended to suggest timing the intervals to the point of tempting failure. It does, however, suggest that the author of the program should schedule with the intention of taking full advantage of what he determines to be the maximum safe maintenance-free period between service intervals. Determination of these intervals may well be influenced by consideration of the following:

- (a) Continuous or intermittent service.
- (b) Seasonal or year-round service.
- (c) Light or heavy duty.
- (d) Type of lubrication: oil or grease-lubricated bearings, sealed, permanently lubricated bearings, crankcase, etc.
- (e) Dollar value of the unit.
- (f) Impact of failure.

Undoubtedly there are other controlling factors that are peculiar to a given installation; however, the last two mentioned, dollar value of the unit and impact of failure, appear to apply universally.

Many a maintenance budget is prematurely exhausted because of so-called "Maintenance Checks" being performed on relatively insignificant items, the life expectancy and/or operating efficiency of which is not materially affected. There are but a few people who consider it necessary or profitable to hire specialists of the various trades to "check" their own home refrigerator, hardware on interior doors, wall light switches, and bathroom plumbing fixtures at frequent and regular intervals. With few exceptions, such "checks" may be regarded with suspicion when scheduled as plant maintenance. A policy that provides these features may well be responsible for an accumulated maintenance expenditure of several times the original or replacement cost of the item; and contribute nothing to longevity or quality of performance.

Certainly, prime consideration must be given to the nature of the function being performed by the item. Obviously, the engineer will not make such a determination on the basis of item cost alone. The necessity for such "services" must be decided at the individual plant level.

It would be difficult, if not impossible, to prescribe in detail an accurate procedure for the development of a programmed maintenance system that would be universally acceptable. Again it is emphasized that there are many problems and restrictions that must be imposed at one installation and will not normally require consideration at another.

Successful accomplishment of many maintenance tasks depends largely on the maintaining of stock levels that assure availability of materials at the required time.

The purchasing agency should be provided with information on materials for which there is a known repetitive requirement. In this manner, lead time is permanently established and stock-level determination is automatic.

It must be acknowledged that more design effort has been directed toward machinery location and environment during the past two decades. The trend is everlastingly to the credit of the architect, as well as the engineer, in providing something more than dark unventilated spaces, which become machine rooms almost solely because they were unusable for some other purpose. Insistence on light and uncrowded machinery areas, with natural and/or mechanical ventilation, is as much a part of a properly engineered maintenance program as it is a design responsibility. It is in the maintenance budget that the results will be reflected.

In the discussion of any maintenance system there must be included the mention of necessity for careful consideration of feed-back information. This is the vitally important final check on the effectiveness and communication. It frequently comes in the form of a complaint from the mechanic but is nonetheless valuable and should be encouraged. It would be obviously unwise, particularly in the maintenance field, to refuse to recognize this potential, which is inherent in an experienced maintenance and operating force of three-hundred men whose combined years of experience will span several centuries.

This does not necessarily imply that all such feed-back information will be accurate, and much of it may be discounted by the engineer. However, each suggestion will be found to be of value and should not be ignored. This is true if for no other reason than to effect a better understanding with the mechanic who is performing the task, and upon whose co-operation and integrity the final success of any maintenance program must depend.

At this installation, the results of a 12-month operational period indicate a marked improvement in performance.

The increased quality of maintenance is evidenced by (a) an average monthly decrease of approximately 700 unscheduled repair requests, many of which were of the emergency type; (b) the lessening of Maintenance Shop's back log for unscheduled overhaul of equipment; (c) unscheduled

down-time for production and research facilities is now regarded as the exception rather than the rule, and finally (and perhaps the most important) (d) the wholly unrecoverable loss of scientific effort in the research and development field due to untimely equipment failure is greatly reduced and there is now hope that it can be virtually eliminated in the near future.

Those responsible for the design and implementation of the maintenance system at Fort Detrick are among the first to admit that perfection has not been achieved. The process of changing, correcting, and upgrading continues as field experience indicates the need.

It can be said, however, without further qualification that Fort Detrick now has an instrument for exercising maintenance control to a high degree, and that maintenance and operation data that have been recorded over the comparatively short period affected clearly indicate that the original objective is well on its way to realization.